BIRTH ORDER EFFECTS AND FLUID/CRYSTALLIZED INTELLIGENCE

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Abstract of Dissertation Presented to the Graduate Council
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The present investigation was an attempt to separate out some of the confounded relationships between the family configuration correlates of ability and achievement performance. In the first study, a battery of 21 tests was administered to 111 university students. After factor analyzing the results for optimal marker variables of the fluid intelligence (G_f--active problem-solving ability) and crystallized intelligence (G_c--achievement-related performance) constructs of Cattell and Horn, four linear structural equation models relating G_c to various hypothesized predictor variables were evaluated in the original university sample, and an additional sample consisting of 65 high school students. The individual models emphasized the importance of either economic, "intellectual environment," physiological, or socio-psychological influences in the mediation of birth order and/or family size effects on intellectual ability performance. It was emphasized that the models were not mutually exclusive, but might be differentially applicable in different populations.

Certain unexpected correlations obtained in the university student sample, which might be specific to such a population, rendered straightforward interpretation of the models difficult. The finding of a significant positive correlation between family size and socioeconomic status was in marked contrast to the often reported negative intercorrelation of these two variables in the general population. This result was discussed in terms of financial resources and limitations, which may play a decisive role in college attendance. The only model supported in this sample was a modified version of the economic model.

The ability of the models to predict G_c performance in a more heterogeneous high school sample was also evaluated. All of the models were better supported in this sample. However, whereas the overall *F* ratio for each of the models was significant, the theoretically expected regressions for the individual predictor variables on G_c were significant only for the economic and socio-psychological models. It was concluded that, not only were these two models able to account for substantial amounts of variance in the prediction of G_c performance, but that the separate paths indicated by both models were strongly supported by the obtained data. After comparing the individual paths postulated by these two models, it was concluded that the socio-psychological model was the optimal predictor of G_c performance. This result was largely attributable to the highly significant regression for the firstborn (versus later-born) variable on G_c.

With regard to the very different results obtained in the college student and high school student samples, it is apparent that one must specify the kind of sample involved when addressing issues related to family configuration and socioeconomic correlates of intellectual ability.

The very positive results obtained for the heterogeneous high school sample indicate the significance of certain social and psychological factors as mediators of family configuration influences--particularly firstborn superiority--on intellectual achievement. Moreover, economic influences seem to exert powerful effects, both directly and indirectly, on intellectual ability performance.

It was suggested that the utilization of innovative statistical techniques and conceptual approaches might serve to more effectively isolate the extremely complex family configuration correlates of intellectual aptitude and achievement.

CHAPTER I

INTRODUCTION

While the relationships of birth order and family size to achievement-related variables have been studied extensively, the conclusions which can be drawn from these research efforts are often contradictory and, at best, tentative. Problems involved in the study of such relationships are complicated by the fact that (a) family size and birth order are highly correlated, (b) personality and ability/achievement are not independent, and (c) socioeconomic status (SES) is correlated with both family size and the personality-ability-achievement complex (Eysenck & Cookson, 1970).

A consistent finding of studies which have related birth order to eminence has been a preponderance of firstborns among eminent individuals (J. M. Cattell, 1927; Ellis, 1904; Galton, 1874; Huntington, 1928). In Terman's (1925) study of gifted children, there were more firstborns than would have been expected by chance. Altus (1965a) reports that the firstborn individual is greatly overrepresented at the college level. Nichols (1964) presents data on National Merit Scholarship finalists. Nearly 60% of the finalists who came from families of two, three, four, and five children were firstborns. Altus (1965b) studies Scholastic Aptitude Test scores and concluded that firstborns in college may be more able verbally than later borns; no differences appeared in mathematical aptitude. Several other studies have found firstborn superiority on various achievement-related measures (Breland, 1974; Burton, 1968; Glass, Neulinger, & Brim, 1974; Marjoribanks & Walberg, 1975).

In addition to the greater achievement of the firstborn, there may exist hierarchies of aptitude among the intellectually able related to birth order and family size. Zajonc (1976) reported that intellectual level generally declines with family size and certain age spacing relationships, which are important in terms of the family's immediate intellectual environment. The dependence of the intellectual development of each family member on that of all other family members is emphasized in this theory. However, the relationships between family size and intellectual performance appear to be attenuated or may disappear in higher SES families. In a study of 11-year-old children, Cicirelli (1967) found that family size and achievement were unrelated. It appears that, in middle and upper-middle SES populations, children from larger families are able to obtain adequate attention and learning opportunities. Kennett (1973) suggests that the acceptance of an inverse relationship between family size and intelligence must be modified by the influence of SES on the relationship, and that correlations may vary from social class to social class.

While firstborn superiority on achievement-related variables has been widely reported, consistent patterns relating decreasing intellectual ability scores to successive birth order position have been less straightforward. Although several studies report hierarchical relationships (Altus, 1965b; Belmont & Marolla, 1973; Breland, 1974; Burton, 1968; Nichols, 1964; Wark, Swanson, & Mack, 1974), findings are often inconsistent. For example, eminence studies (Apperly, 1939;

J. M. Cattell, 1927; Clarke, 1916; Ellis, 1904; Terman, 1925; Yoder, 1894) report a preponderance of firstborns and lastborns among persons of genius. Similarly, studies of birth order among older children and young adults often demonstrate superiority of firstborn over later-born children on IQ and achievement, with the middle child frequently making the poorest score (Cicirelli, 1967; Corliss, 1964; Hall, 1963; Lees & Stewart, 1957; Maxwell & Pilliner, 1960; Rosenberg & Sutton-Smith, 1964; Schachter, 1963). Record, McKeown, and Edwards (1969) report that the strong association between verbal reasoning scores and birth order in the general population is mainly due to differences between rather than within families. In upper SES families the difference between consecutive siblings (0.7 IQ points) is small, but in poorer families the difference (2.0 IQ points) is considerable.

The reasons for these discrepant data are unclear. Marjoribanks, Walberg, and Bargen (1975) report that birth order effects are rarely unitary, but often involve other familial aspects, such as the sex of the siblings and their differences in age. Cicirelli (1967) found that such sibling constellation factors were related to measures of creativity, arithmetic ability, and language achievement in a sixth-grade sample.

Birth Order/Family Size Theories

There are at least four major points of view concerning birth order and family size influences on intelligence. The theories considered in this investigation emphasize the importance of either economic, "intellectual environment" (confluence), physiological, or socio-psychological factors in the determination of birth order and family size correlates of intellectual ability and achievement. These models will be discussed individually.

Economic Model

Many investigators contend that birth order and family size effects are largely reducible to SES and the economic factors involved. For example, in the past the concept of primogeniture (the exclusive right of inheritance bestowed on the eldest son) was directly related to economics. Anastasi (1956) reports a negative correlation of IQ with family size, which disappears or becomes positive in higher SES levels. Nisbet and Entwistle (1967) note a negative correlation of family size with intellectual ability in school children, an effect which is attenuated in upper SES groups. Kennett (1973) found a significant inverse relationship between family size and IQ in junior high school students, except in the upper two SES categories. Marjoribanks et al. (1975) report that, while children with more siblings tend to score lower on verbal and number ability tests, the relation is attenuated in high SES families. Schooler (1972, 1973) contends that birth order effects can be most parsimoniously explained in terms of differences among SES trends in family size. These studies suggest a changing relationship between family size and intelligence in different SES groups.

Zajonc-Markus Confluence Model

In the confluence model (Zajonc, 1976; Zajonc & Markus, 1975), ordinal differences in intelligence are explained in terms of family size and age spacing between siblings. Zajonc and Markus attempt to account for the effects of the immediate "intellectual environment" (represented as a function of the average of the absolute intellectual levels of the family members) on intellectual development, and to specify how individual differences emerge in the social context of the family. For example, if the parents' intellectual levels are 30 arbitrary units each, the birth of the first child, whose intellectual level is zero, would cause the family intellectual environment to have an average value of (30 + 30 + 0)/3 = 20. If a second child is born when the first child's intellectual level reaches 4, the second born enters an environment of (30 + 30 + 4 + 0)/4 = 16. The importance of age spacing between siblings could be seen, for example, if the second child were not born until the firstborn child reaches an intellectual level of 24. The newborn would enter an environment of (30 + 30 + 24 + 0)/4 = 21, even more favorable than the environment of 20 entered into by the firstborn. Negative effects of birth order can be nullified and even reversed with large enough age gaps between siblings, according to this model. In addition, it is proposed that only children and last-born children suffer a handicap due to their lack of opportunity to serve as teachers to younger siblings. Thus, it is suggested that the intellectual growth of each family member is dependent on that of all the other members, and that the rate of growth depends on family configuration.

Physiological Model

Proponents of this point of view discuss the effects of increased chance of genetic error and "uterine fatigue" with later-born children

(Forer, 1976). Warren (1966) indicates that the intrauterine environment may vary with the mother's age and number of previous pregnancies. Such influences would favor earlier-born children. However, a smaller placenta, longer labor, increased perinatal complications, and increased use of forceps are often associated with pregnancy and birth of the firstborn, influences which would favor later-born children (Weller, 1965). Thus, it is evident that the physiological model may suggest quite complex effects of family configuration.

Socio-Psychological Model

Much recent research has supported the importance of socio-psychological variables related to birth order and family size. Many studies indicate personality differences between different birth orders and with differing family sizes (Eysenck & Cookson, 1970; Forer, 1976). Bradley (1968) discusses personality factors which favor firstborns in school-related behaviors:

> Firstborns seem to more frequently (a) meet teachers' expectations and (b) show more susceptibility to social pressure than later borns. Exhibiting (c) greater information-seeking behavior and (d) being more sensitive to tension-producing situations, firstborns may be judged by others as (e) serious and (f) low in aggression. These behaviors may (g) strengthen firstborns' achievement motivation and (h) help to enhance their academic performance. (p. 45)

Start and Start (1974) studied teacher ratings of first-grade children. Firstborns received higher teacher estimates of conscientiousness and effort. Glass et al. (1974) propose two related processes to account for the higher verbal ability and educational aspirations of firstborns. They suggest that better-educated parents encourage higher aspirations and verbal skills in their children, and that this phenomenon is especially true for earlier-born children:

> The later child generates and moves into relationships uniquely its own--"the principle of unoccupied space"--specifically different from the role of the "achieving child", which is already filled in the family. (p. 80)

Burton (1968) found a decreasing progression of IQ with birth order. However, the mean difference between firstborn and last born was approximately 3 IQ points, a difference unlikely to have any practical effects on the achievement of firstborn relative to that of last born. He suggests that research on birth order effects should focus on socio-psychological variables associated with ordinal position.

In an investigation of family size and sibling spacing effects (Nuttall, Nuttall, Polit, & Hunter, 1976), there emerged a sex-specific pattern of relationships between family size and academic achievement. The authors discuss the significant family size effect for boys and the significant firstborn effect for girls in terms of socio-psychological factors. However, because none of the proponents of the four models emphasized sex differences as a major contributing factor to family configurational correlates of intelligence, sex was not included as a predictor variable in these analyses.

Thus, although the reasons for the relationships are not at present clear, ordinal position at birth appears to be importantly related to significant social factors.

It is therefore evident that birth order and family size influences on intelligence can be discussed in terms of economic, physiological, age-spacing and/or socio-psychological variables. It must be emphasized that these theories are not mutually exclusive. Socioeconomic status is inextricably related to other variables. For example, influences of birth order and family size are largely attenuated in higher SES groups.

Prenatal care and diet, as well as family interaction patterns, are related to social class. In higher SES populations later-born children and children from larger families do not appear to manifest the handicaps generally found in lower SES populations. Thus, it is apparent that, as one moves up the SES scale, economic, physiological, and age-gap variables exert less influence and socio-psychological variables exert relatively more influence on the birth order and family size correlates of intelligence and achievement.

Fluid and Crystallized Intelligence

In a study of the relationships of Primary Mental Ability Test scores to birth order, Marjoribanks et al. (1975) found that verbal and number abilities, but not reasoning and spatial abilities, were sensitive to ordinal position effects. The authors discuss the results in terms of the differential influences of the fluid and crystallized intelligence constructs of R. B. Cattell and Horn (Cattell, 1941, 1963, 1967; Horn, 1966, 1968, 1970, 1975; Horn & Cattell, 1966, 1967). Horn (1970) contends that, during development, a number of factors interact to make possible the appropriation of large sections of the "collective intelligence" of a culture (represented by crystallized intelligence, or G_c). He emphasizes the importance of the quality of both school and home environments in promoting and shaping an individual's crystallized intelligence. On the other hand, fluid intelligence (G_f), or active problem-solving ability, is purported to reflect the functioning of the neurological structures and is thus much less influenced by accultura-tional factors:

> A major implication of this theory is that at some order of analysis in factoring among ability performances two very broad factors, each having properties of what is putatively intelligence, should be distinguishable. One of these factors should be defined primarily by abilities which can be seen to be quite closely related to intensive acculturation, whereas the other should be defined primarily by abilities which are less closely linked to this. (p. 444)

The greater sensitivity of verbal ability, as compared to active problem-solving ability, to environmental factors suggests that ordinal position influences can be best explained in terms of social rather than physiological factors (Murray, 1971). If Horn's contention is correct, and if environmental factors within the family are the major determinant of ordinal position effects on achievement-related measures, there should be a significant birth order effect on G_c measures, whereas there should be no significant birth order effect on G_f measures.

Due to the important socio-psychological factors related to ordinal position, it was predicted that firstborns would score higher than later borns on achievement-related variables (G_c). Firstborn superiority was not predicted for G_f measures, which purportedly reflect neurophysiological functioning. A large battery of tests, hypothetically related to G_f, G_c, and other closely related cognitive abilities, were administered to 111 college students and factor analyzed in order to select optimal marker variables of fluid and crystallized intelligence. Four linear structural equation models representing the economic, Zajonc and Markus confluence, physiological, and socio-psychological points of view are illustrated in Figure 1. In addition to comparing these models in terms of the overall variance accounted for in the observed results and the predictive ability of the individual

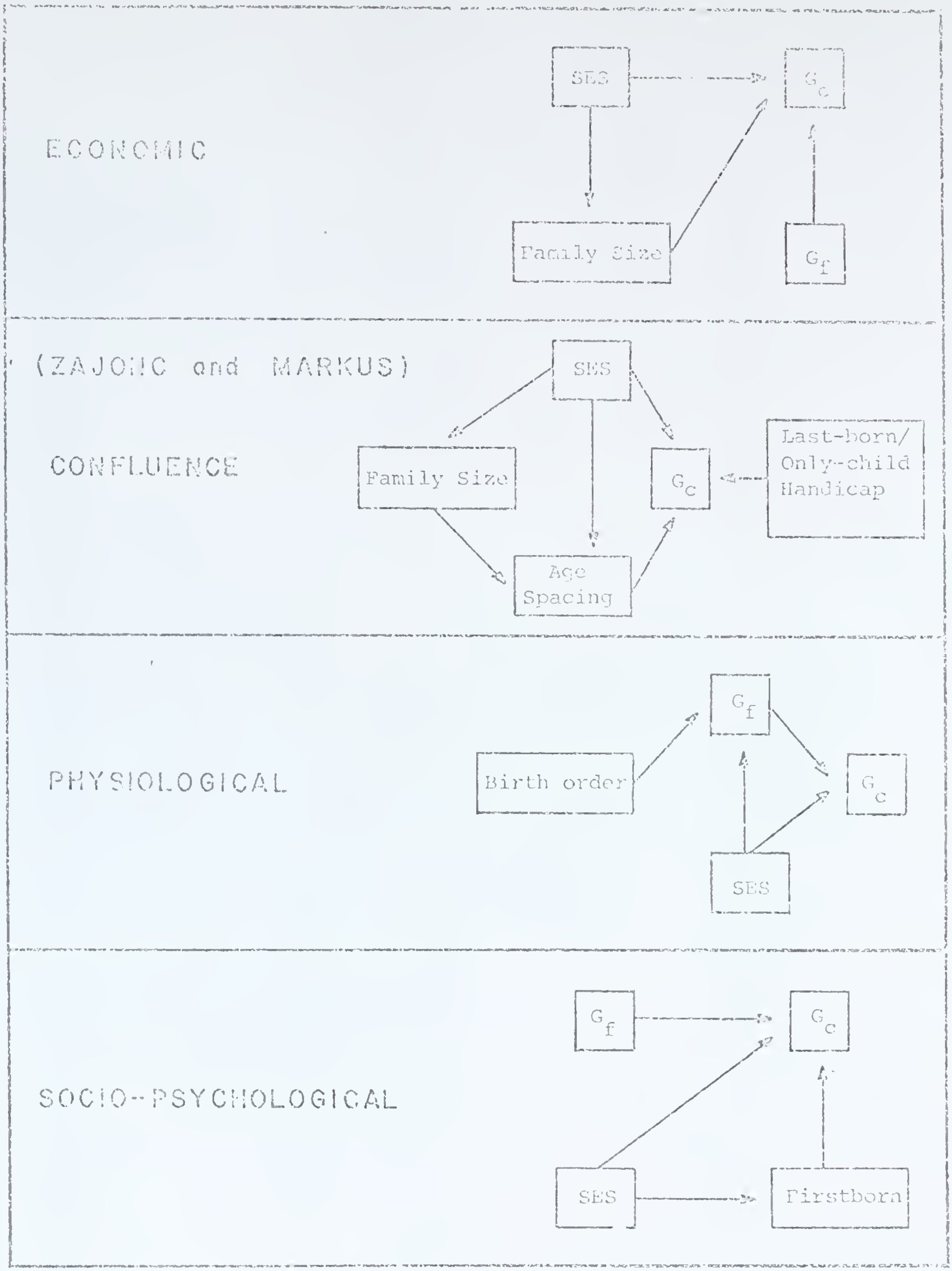


Figure 1

Linear Structural Equation Models

hypothesized components of each model, certain assumptions concerning causal order were examined using path analysis procedures. Although path analysis should not be considered a method for demonstrating causality, it can be used to examine a set of causal assumptions imposed on a system of relationships. Different deterministic relationships between the predictor variables and achievement-related performance were posited by the four models. Essential to the assumptions of the models was the order of inclusion of the predictors, which implies the existence of certain relationships among the variables, including direct and indirect influences on the criterion variable. Moreover, potentially redundant predictors can only be identified with later inclusion in the model. Multiple regression procedures are used to estimate the relative strength of the individual paths. These results indicate the magnitude of direct and indirect (redundant) influences in terms of the hypothesized causal order among the variables posited for each individual model.

Since Cattell and Horn (Cattell, 1941, 1963, 1967; Horn, 1966, 1968, 1970, 1975; Horn & Cattell, 1966, 1967) postulate an important deterministic relationship between G_f and G_c, the G_f variable was entered first in the three models which included G_f as a predictor variable. The order of inclusion of the predictor variables and the underlying assumptions involved will be discussed separately for each model.

Predictors of G_c in the economic model were included in the following order: G_f, family size, and SES. Family size was considered to be independent from G_f since no neurophysiological correlates of family size were discussed in this model. Due to the attenuation of family size influences often reported for higher SES levels (Anastasi, 1956; Kennett, 1973; Marjoribanks et al., 1975; Nisbet & Entwistle, 1967; Schooler, 1972, 1973), SES was considered to influence G_c both directly (economic advantages and restrictions in terms of educational and occupational opportunities) and indirectly (through differential influences on the family size correlates of achievement). SES was therefore entered as the third variable in the multiple regression analysis for this model.

Very different relationships were suggested by Zajonc and Markus in the confluence model. The proposed handicap of last-born and only children was the first variable to enter due to its postulated direct influence on G_c, independent of the other predictors. For example, Zajonc and Markus (1975) treated "handicap" as a dummy variable--equal to 0 for last-born and only children or 1 otherwise--in the regression equation used to describe the Belmont and Marolla (1973) birth order-IQ results. Since neuro-physiological influences were not discussed by Zajonc and Markus, G_f was not included as a predictor variable. The second and third variables to enter into the equation were sibling age spacing and family size, respectively. Although highly confounded, both variables were considered important mediators of intellectual ability in this model. Since age spacing was considered a potentially more important correlate of intellectual ability, it was included before family size. The SES variable was entered last due to its complex interrelationships with the other variables postulated by the confluence model.

The first variable entered into the analysis of the physiological model was G_f, purported to reflect neurophysiological functioning and integrity. Since economic factors were discussed in terms of their role in the mediation of certain physiological influences (including diet, prenatal care, and health), SES was entered next. Birth order--discussed in terms of increased genetic error, "uterine fatigue," and perinatal complications (Forer, 1976; Warren, 1966; Weller, 1967)--was postulated to be only a potentially important influence on neurophysiological functioning (G_f), and was thus the third variable to be considered in this multiple regression analysis.

The first variable entered into the socio-psychological model was G_f, as discussed above. Glass et al. (1974) contend that the higher verbal abilities and educational aspirations of firstborn children may be particularly prevalent at higher SES levels. The second and third predictor variables to enter this equation were firstborn (versus laterborn) and SES, respectively. The SES variable was entered last due to its potentially important mediation of birth order influences and possible direct influence on achievement-related performance through economic resources and limitations (Forer, 1976).

Thus, the results of the present study should not only indicate the predictive ability of these four models in terms of G_c performance, but the evaluation of the individual components of the models may uncover subtle interrelationships, both direct and indirect, among the predictor variables themselves and with regard to their prediction of achievement-related performance. Moreover, the present results should hopefully clarify certain issues pertaining to the relationships between ordinal position and aptitude (theoretically represented by G_f measures) versus achievement-related measures (theoretically represented by G_c ability).

CHAPTER II

METHOD AND DATA ANALYSIS

Overview and Design

In an effort to evaluate the influence of various family size variables, birth order variables, and fluid intelligence (G_f) on crystallized intelligence (G_c), three separate procedures were carried out. A preliminary factor analysis was performed on a large battery of tests administered to 111 university students in order to identify optimal marker variables for G_f and G_c. Following the factor analysis, the most highly loading tests for each of these two constructs were combined and utilized as variables in four linear structural equation models relating G_c to various hypothesized determiners, including G_f and several sibling/family relationship variables. The models were evaluated separately for two groups: (a) the original college student sample; and (b) a sample consisting of 65 high school students.

Study 1

Subjects. A sample, consisting of 111 university students, including seven graduate students, was recruited for test administration by classified advertisement in the campus newspaper. Since this sample was to be included as part of a larger grant-supported investigation of cognitive abilities and aging, each subject was paid $10 for participation. The sample consisted of 57 male and 54 female white, middle and upper-middle SES students. The age range of the subjects was 17 to 30 years, with a mean age of 20 years.

Instruments. A battery of 21 tests which were hypothesized to represent G_f, G_c, and other closely related cognitive factors were administered to the subjects by the author. The group test administration was approximately four hours in length, with two 10-minute rest intervals. The tests, in their order of presentation, included the G_f-G_c "Sampler," an unpublished battery of tests constructed by Horn which consists of three tests designed to represent G_f and two tests designed to represent G_c, the Army Alpha Examination (First Nebraska Edition, Guilford, 1938), four subtests of the Primary Mental Abilities (PMA) battery (Thurstone & Thurstone, 1949), three Educational Testing Service (ETS) measures of French, Ekstrom, and Price (1963), and the Omelet Test from the Structure-of-Intellect measures (Hoepfner & Guilford, 1969). A description of each measure follows:

1. Vocabulary (Horn "Sampler"). Subjects are asked to select the word which is closest in meaning to a given word from five test words. There are 20 items in this subtest. This test, like all of Horn's test in the present investigation, was untimed.

2. Analogies (Horn "Sampler"). This test consists of fairly simple verbal analogies in the form: "A is to B as C is to __." In each of 15 items the subject is given five test words from which to choose the appropriate answer. Since the words are relatively simple, perceiving

the relationship between them is theoretically what is evaluated, which should reflect G_f ability.

3. High-Level Vocabulary Analogies (Horn "Sampler"). This test involves exactly the same format as Horn's Analogies Test. However, this test consists of more difficult verbal analogies in the sense that it contains higher-level vocabulary words designed to involve more advanced verbal ability, thus reflecting G_c ability.

4. Letter Series (Horn "Sampler"). After examining a sequence of from 5 to 15 letters, the subject is required to write the next letter in the series in a blank space which follows the sequence (15 items).

5. Figural Relations (Horn "Sampler"). Subjects are presented with a square form with geometric, simple figural, and letter patterns in 3 out of 4 quadrants, and, on the basis of the interrelationships of these figures, must select from several choices the appropriate figure for the fourth quadrant (20 items).

6. Following Directions (Army Alpha). Subjects must carry out verbally presented instructions on items consisting of geometric and letter patterns. Short-term memory ability is required for the rapid execution of these 12 items.

7. Arithmetic Problems (Army Alpha). This test consists of verbal problems which require arithmetic manipulations.

8. Common Sense (Army Alpha). This test involves questions designed to evaluate practical judgment and reading comprehension.

9. Synonym-Antonym (Army Alpha). Subjects must designate whether 40 sets of word pairs are the same or opposite in meaning.

10. Disarranged Sentences (Army Alpha). After mentally re-arranging a set of words in order to make a sentence, subjects are instructed to

indicate whether each of the resulting 24 sentences is true or false.

11. Number Series Completion (Army Alpha). Subjects must examine the relationship which exists within a series of numbers and indicate what two numbers should logically follow (for each of 20 number series).

12. Analogies (Army Alpha). After determining the relationship between a pair of words, subjects must select one of a group of four words which is related to a second word in an analogous manner.

13. Information (Army Alpha). Subjects must answer 40 multiple-choice items which involve general information.

14. Word Grouping Test (PMA). In this test the ability to understand and group words of the same type is involved. Subjects must select which of five presented words does not belong with the other words. Each of the PMA subtests is timed.

15. Letter Series Test (PMA). This test consists of 20 letter series, each of which has a specific pattern. The task is to select which of five letters should logically follow for each individual letter sequence.

16. Spatial Relations Test (PMA). Subjects are presented with 30 geometric forms, to the right of which are five similar or identical forms which have been rotated to different positions. The task is to identify which of these forms are identical to the original form.

17. Number Series Test (PMA). This test consists of 20 multiple-choice items in which the task is to select the number which should come next in a distinctive pattern of numbers.

18. Addition Test, N-1 (ETS). This two-part test assesses how quickly and accurately subjects can add series of numbers. The time limit is two minutes for each 60-problem part.

19. Number Comparison Test, P-2 (ETS). This is a highly speeded test consisting of two parts. The task is to compare two series of numbers (the pairs of number sequences are of different lengths) and indicate whether or not they are the same by inserting an X between the number series that are not identical.

20. Identical Pictures Test, P-3 (ETS). This is a two-part test in which subjects must select from five alternative pictures the one that matches a target picture.

21. Omelet Test (Hoepfner & Guilford, 1969). In this test the task is to rearrange sets of four letters each to make familiar words. This test was constructed to measure Guilford's Structure-of-Intellect factor of convergent production, defined as the "generation of logical conclusions from given information where emphasis is upon achieving unique or conventionally best outcomes" (Guilford & Hoepfner, 1971, p. 20).

Variables. The variables included for analysis were determined by the assumptions of the four models, which are illustrated in Figure 1. The G_c construct was the criterion variable for each model. The predictor variables included G_f, SES, birth order, family size, firstborn (as opposed to later-born siblings), age spacing between siblings, and the "handicap" of the only child and last-born child (Zajonc & Markus, 1975). The SES scale utilized in this study was a composite of three separate standardized variables: (a) prestige value of father's occupation (Treiman, 1977); (b) father's educational level; and (c) mother's educational level. Educational level was rated along a 6-point scale, from "not a high school graduate" to "doctorate." The number of children in the families in this sample ranged from 1 to 13, with a mean family size of 3.432. There were 40 firstborns (including four only children).

Birth order ranged from 1 to 11 (mean = 2.234). In order to normalize the extremely skewed birth order distribution, birth order was divided into three categories before any further analysis took place. These categories were: (a) firstborn ($\underline{n}$ = 40); (b) second- or third-born ($\underline{n}$ = 56); and (c) fourth- or later-born ($\underline{n}$ = 15). The adjusted percentages of the total sample for these three categories were 36%, 50%, and 14%, respectively. The sample included 36 middle children and 35 lastborn children. Due to certain assumptions specific to the different models, two dichotomizations of birth order frequencies were calculated. The firstborn (versus later-born) construct was a predictor variable in the socio-psychological model. The "last-born/only-child handicap" was included as a variable in the Zajonc and Markus confluence model. This category included 39 subjects. In addition, this model proposed that age spacing between siblings would be an important correlate of intellectual development. Age spacing was calculated as the sum of two separate indices, the number of years to the next oldest sibling and the number of years to the next youngest sibling. Since this model proposed that an arbitrary maximum intellectual level of 100 would be attained at approximately 19 years of age, 19 years was used as the maximum age separation index. For example, the age spacing index for an only child would be (19 + 19) = 38. This somewhat crude index of age spacing between siblings was utilized die to the extreme difficulty encountered when attempting to calculate each individual subject's intellectual level according to the sigmoid function presented by Zajonc and Markus (1975). This equation was analyzed in terms of average age gaps, not individual age separation data. Other approaches to this age gap index have included mean age separation between siblings (McCutcheon, 1977) and median number of months separating the siblings in the entire family (Nuttall et al., 1976).

The means and standard deviations of the variables for the college student sample are listed in Table 1.

Factor Analysis. A 21-by-21 variable correlation matrix was computed from the scores of the 111 subjects on the 21 measures. The factor analysis was carried out with the Exploratory Factor Analysis Program (EFAP), devised by Jöreskog and Sörbom (1976a). Rotation was by the Promax method, utilizing the Varimax orthogonal rotation procedure as the basis for the subsequent oblique solution.

Maximum likelihood procedures (Jöreskog & Sörbom, 1976b) of factor extraction were utilized to obtain 4- through 10-factor solutions. The most easily interpretable solution appeared to be the 4-factor solution. The factor loadings and factor correlation matrix are found in Table 2. The first factor seemed to be a numerical facility factor which had substantial loadings on the two number series tests, the Addition Test, Arithmetic Problems, and also the Omelet Test. Inclusion of the Omelet Test suggests the possibility that convergent production may be involved in the first factor. Factor II appeared to be a verbal ability factor, hypothetically representing G_c. Tests which had interpretable loadings on this factor included Vocabulary, High-Level Vocabulary Analogies, Synonym-Antonym, Information, Common Sense, Disarranged Sentences, Common Analogies, and the Word Grouping Test. The loading of Horn's Common Analogies subtest on this factor was somewhat surprising since this measure was constructed as a marker of G_f ability. However, the low correlations of this test with other nonverbal measures

Table 1

Means and Standard Deviations for College Student Sample

	Mean	Standard Deviation
Age	20.2160	1.9970
Family Size	3.4324	1.6713
Birth Order	2.2340	1.4270
Mother's Education	2.8200	1.1380
Father's Education	3.3578	1.3846
Occupational Prestige	50.4364	13.1961
Age-Spacing Index	17.9550	8.8360
Vocabulary[a]	10.8830	2.0960
Vocabulary Analogies[a]	10.6220	2.2360
Common Analogies[a]	11.6577	1.8360
Letter Series[a]	12.4230	1.8660
Figural Relations[a]	14.6130	2.9300
Following Directions[b]	9.4050	1.7960
Arithmetic Problems[b]	11.9910	2.8170
Common Sense[b]	11.5500	2.4600
Synonym-Antonym[b]	30.8010	5.1610
Disarranged Sentences[b]	20.2700	2.6250
Number Series[b]	14.6670	3.3070
Analogies[b]	34.5860	4.6720
Information[b]	29.3330	3.2680

Table 1 - continued

	Mean	Standard Deviation
Word Grouping[c]	23.3330	3.1400
Letter Series[c]	15.1530	2.7640
Spatial Relations[c]	120.4230	13.1670
Number Series[c]	11.5860	2.8870
Addition[d]	43.1980	13.2110
Number Comparison[d]	26.1350	5.9980
Identical Pictures[d]	79.4180	11.4440
Omelet Test[e]	21.5590	4.8570

[a] Horn "Sampler"
[b] Army Alpha Examination
[c] Primary Mental Abilities Test
[d] Educational Testing Services
[e] Sheridan Psychological Services

Table 2

Promax Rotated Factor Loadings

	Numerical Facility	G_c	Speed	G_f
	1	2	3	4
Common Analogies[a]	0.006	<u>0.465</u>	-0.132	0.178
Analogies[b]	-0.085	<u>0.693</u>	0.133	0.119
Word Grouping[c]	0.021	<u>0.701</u>	-0.179	0.175
Letter Series[a]	0.160	0.115	-0.046	<u>0.565</u>
Letter Series[c]	0.157	0.043	0.118	<u>0.630</u>
Figural Relations[a]	0.063	0.008	-0.019	<u>0.530</u>
Spatial Relations[c]	-0.031	-0.135	0.058	<u>0.716</u>
Number Series[b]	<u>0.730</u>	-0.109	-0.002	0.357
Number Series[c]	<u>0.741</u>	-0.013	0.001	0.138
Following Directions[b]	0.074	0.230	0.067	0.312
Vocabulary[a]	-0.263	<u>0.792</u>	0.026	0.076
Vocabulary Analogies[a]	0.071	<u>0.663</u>	-0.091	0.022
Synonym-Antonym[b]	-0.053	<u>0.734</u>	0.268	-0.239
Information[b]	0.150	<u>0.779</u>	-0.213	-0.068
Arithmetic Problems[b]	0.387	0.209	-0.018	0.300
Addition[d]	<u>0.498</u>	-0.092	<u>0.504</u>	0.055
Number Comparison[d]	0.065	-0.057	<u>0.756</u>	0.088

Table 2 - continued

	Numerical Facility	G_c	Speed	G_f
	1	2	3	4
Identical Pictures[d]	-0.122	0.094	0.287	0.290
Common Sense[b]	0.020	<u>0.648</u>	0.225	-0.076
Disarranged Sentences[b]	0.137	<u>0.470</u>	0.074	-0.022
Omelet Test[e]	<u>0.448</u>	0.132	0.227	-0.055

Factor Correlations

	1	2	3	4
1	1.000			
2	0.413	1.000		
3	0.325	0.273	1.000	
4	0.453	0.448	0.263	1.000

[a] Horn "Sampler"
[b] Army Alpha Examination
[c] Primary Mental Abilities Test
[d] Educational Testing Services
[e] Sheridan Psychological Services

may have been a result of the restriction of range in this particular sample. It would be informative to analyze the intercorrelations of these tests in a more heterogeneous sample. Factor III was a highly speeded factor, which had its highest loading on the Number Comparison Test. Factor IV, hypothesized to represent G_f, had interpretable loadings on the two letter series tests, Figural Relations, the Spatial Relations Test, Number Series Completion, and the Following Directions Test. Factor interrelationships were moderately oblique ranging from .263 to .453.

After interpreting the factor loading matrix, it was decided that the five best marker variables of the G_f construct were: (a) the PMA Letter Series Test; (b) the PMA Spatial Relations Test; (c) the Army Alpha Number Series Completion Test; (d) Horn's Letter Series subtest; and (e) Horn's Figural Relations subtest. Since the two letter series tests were measures of the same ability, it was decided to combine them as a single measure in the G_f composite. The measures selected to represent G_c were: (a) the PMA Word Grouping Test; (b) the Army Alpha Synonym-Antonym subtest; (c) the Army Alpha Information subtest; (d) Horn's Vocabulary subtest; and (e) Horn's High-Level Vocabulary Analogies subtest. The marker variables for both composites were individually standardized before being added together. As has been found in the past (Horn, 1970, 1975) and is expected theoretically, the G_f and G_c composite scores were substantially positively intercorrelated, $\underline{r} = +.3674$, $\underline{p} < .01$.

Study 2

Subjects. The sample consisted of the same 111 university students examined in the previous study.

Method. A multiple regression procedure was employed to examine the results in terms of both the overall variance accounted for in the observed data and the hypothesized causal orderings for the individual components for each of the models described in Chapter 1. Multiple regression was the method of choice since it is a statistical technique which permits analysis of the relationship between a criterion variable and a set of predictor variables. A hierarchical specified inclusion method was used. The criterion variable for each model was G_c. This procedure permits the addition of variables to the regression equation in a predetermined order. The estimation of the relative strengths of the individual paths indicates the magnitude of direct and indirect influences in terms of the hypothesized causal order posited for each model. The order of inclusion of the predictor variables was determined a priori by the author with regard to the hypothesized influences of family configuration variables and SES on intellectual aptitude and achievement as specified by the individual models. In the economic model, such influences are discussed in terms of SES and the related economic advantages and restrictions. Physiological mediators of birth order differences in cognitive ability are considered in the physiological model. In the confluence model, ordinal differences in intellectual ability are discussed in terms of family size and age spacing between siblings. The relationship of social and psychological influences and birth order differences are emphasized in the socio-psychological model. These models, which are illustrated in Figure 1, are presented in more detail in Chapter 1.

In the hierarchical decomposition procedure, each predictor variable is added to the equation in a single step, and the increment in R^2, or the explained variance, at each step is considered to be the component of variation attributable to that particular variable, given the contribution of the other variables to the equation. The first predictor is evaluated by the F ratio:

$$F = \frac{r_y^2 1/1}{(1 - R_y^2 \cdot 12, \ldots, k)/(N - k - 1)}$$

where $r_y^2 1$ is the incremental sum of squares due to the independent variable X_i, $1 - R_y^2 \cdot 12, \ldots, k$ is the sum of squares of the residuals, N is the sample size, and k is the number of independent or predictor variables. Each successive predictor variable is tested by an F ratio with 1 and $(N - k - 1)$ degrees of freedom. This procedure indicates the total influence of each successive variable since it refers to adjustments only for those variables that precede each given variable in a predetermined order of inclusion.

The F ratios were calculated for each model and for the inclusion of each predictor variable within each model. In addition, the models were compared to each other for overall variance accounted for in terms of the obtained data. The computer methodology used to evaluate these results was outlined in the Statistical Package for the Social Sciences (SPSS), edited by Nie, Hull, Jenkins, Steinbrenner, and Bent (1975).

Results. Since G_c ability may be much more sensitive to acculturational and environmental influences than G_f ability, which purportedly reflects neurophysiological functioning, it was hypothesized that there would be a significant birth order influence on the G_c construct, but not on the G_f construct. As predicted, while the correlation between birth order and G_c was significant ($r = -.1633$, $p < .05$), the correlation between birth order and G_f was not significant ($\underline{r}$ = .0710). Since no significant birth order patterns were found for the G_f construct, it appears that birth order differences are not mediated by neurophysiological factors in the present sample.

However, the prediction that, due to certain socio-psychological influences related to ordinal position, particularly in the restricted SES range of the present sample, that firstborns would obtain higher scores than later borns on G_c but not on G_f measures was not upheld. While the correlations of the firstborn (versus later-born) variable on the G_c and G_f constructs were in the predicted direction ($\underline{r}$ = .1398 and $\underline{r}$ = .0393, respectively), neither correlation was statistically significant.

Results of the multiple regression analyses are listed in Table 3. Although three of the models--economic, physiological, and socio-psychological--obtained significant overall $\underline{F}$ ratios ($\underline{p} < .01$), it is evident that these results were attributable to the highly significant $\underline{F}$ ratio obtained in the first step in the equations, i.e., the regression of G_f on G_c. None of the other predicted paths between the predictor variables and G_c were significant for any of the models. Regarding the Zajonc and Markus confluence model, neither the overall $\underline{F}$ ratio nor any of the predicted paths were significant. The overall variance explained by the economic, confluence, physiological, and socio-psychological models was approximately 18%, 8%, 17%, and 17%, respectively. Thus, although the economic model appeared to be the most predictive model in terms of variance accounted for, the explained variance was not large in absolute terms.

Table 3

Multiple Regression of Predictor Variables for College Sample

Model Predictor[a]	*df*	R^2	R^2 Change	Simple *r*	beta	*F*
Economic	3/104					7.46583**
1. G_f	1/104	.13495	.13495	.36736	.35772	17.06068**
2. Family Size	1/104	.15468	.01973	-.14783	-.17085	2.03193
3. SES	1/104	.17720	.02252	.13399	.15322	2.31926
Confluence	4/103					2.29886
1. Handicap	1/103	.01497	.01497	-.12235	-.20769	1.68013
2. Age Gaps	1/103	.03092	.01595	.03471	.04255	1.79012
3. Family Size	1/103	.05771	.02679	-.14783	-.22828	3.00673
4. SES	1/103	.08196	.02425	.13399	.15915	2.72167

Table 3 - continued

Model Predictor[a]	df	R^2	R^2 Change	Simple r	beta	F
Physiological	3/104					7.23714**
1. G_f	1/104	.13495	.13495	.36736	.35075	16.97484**
2. SES	1/104	.14917	.01422	.13399	.13841	1.78868
3. Birth Order	1/104	.17271	.02354	-.16330	-.15500	2.96101
Socio-Psychological	3/104					6.86176**
1. G_f	1/104	.13495	.13495	.36736	.35749	16.80573**
2. Firstborn	1/104	.15069	.01574	.13980	.12684	1.96015
3. SES	1/104	.16523	.01454	.13399	.12070	1.81071

Note. The F value on the same line as each specific model name indicates the overall F of the model.

[a]Numbers preceding predictor variables indicate their order of inclusion into the hierarchical regression analysis.

*$p < .05$.

**$p < .01$.

Therefore, upon initial investigation, it appeared that none of the four models could effectively account for G_c in the present sample. The possibility was considered that these negative results were largely attributable to the restriction in range of the present university student population. Upon closer analysis, however, certain unexpected relationships within this particular sample were uncovered. It became apparent that, besides restriction in range, certain relationships related to SES and family size which might be specific to a college sample were statistically suppressing certain predicted family configurational influences. Specifically, these relationships appear to have suppressed the correlations between several of the predictor variables and the criterion variable G_c. It was decided to use partial correlation procedures to separate out some of these relationships. Since partial correlation statistically controls for the effects of one or more specified variables on the relationship between other variables, this technique can be utilized to uncover suppressor relationships. The general form of suppressor influences can be described as: _A_ shows no relationship to _B_ because _A_ is negatively related to _C_ which is positively related to _B_. Thus, when the effects of _C_ are controlled, _A_ may be positively related to _B_. Further assumptions and issues concerning such suppressor relationships will be discussed in further detail after discussion of the unexpected SES-family size relationships found in the college student sample.

SES-family size relationships which may be specific to university student samples. Several unexpected relationships among the predictor variables in the present sample may have suppressed their relationship to G_c. These results rendered straightforward interpretation of the models difficult. It is conceivable that certain possibly artifactual relationships may be specific to college student samples. Such relationships may complicate attempts to generalize from more heterogeneous populations regarding family configurational influences. Schooler's (1973) contention that birth order effects do not appear to persist into adulthood may be particularly apparent in a college sample. Firstborn overrepresentation appears to be the stablest finding reported in studies of university students (Altus, 1966; Capra & Dittes, 1962; Schachter, 1963). The finding that 36% of the current sample were firstborns was slightly, although not significantly, higher (Z = 1.3803, p <.10) than the expected 30% firstborn representation for this particular age group (Dunn, 1956).

Family size effects. Kennett (1973) discusses the changing relationship between family size influences on intellectual ability. He suggests that the acceptance of a negative correlation between family size and intelligence must be qualified by the possibility that SES may influence the relationship. Thus, the correlations may vary from social class to social class. In this regard, perhaps the most surprising finding in the present college sample was the significant positive correlation between family size and SES (r = +.1972, p <.02). This finding was in marked contrast to the widely reported negative correlation between these two variables in the general population (Belmont & Marolla, 1973; Eysenck & Cookson, 1970; Murray, 1971; Nisbet & Entwistle, 1967; Record et al., 1969). The observation that students in this sample who belong to larger families also tend to be of a higher SES level suggests that financial resources and related issues may play an important and perhaps decisive role in the opportunity to attend college. This positive relationship between family size and SES might be expected to be even more substantial in a private, more expensive institution.

Birth order effects. Family size and birth order are highly confounded variables, as evidenced by their substantial intercorrelation of +.4775 ($p < .001$). While the economic model and the confluence model discuss family configurational influences primarily in terms of family size effects, the physiological model posits such effects in terms of sibling birth order while the socio-psychological model emphasizes the influence of firstborn versus later-born on G_c.

Family size and, therefore, birth order are negatively correlated with SES in the general population. However, in the college student sample who participated in this study, there existed a positive although nonsignificant correlation between these two variables ($r = +.1200$, $p < .10$). Despite the possibility that this positive intercorrelation may have suppressed to some extent the negative correlation between birth order and G_c, as was predicted by the physiological model, the obtained correlation between birth order and G_c was nevertheless significant ($r = -.1633$, $p < .05$).

Statistical Suppression

Cohen and Cohen (1975) discuss the effects of three types of suppressor relationship--classical, net, and cooperative suppression--on the patterns of association between the predictor variables. In the present sample, the positive correlation between family size and SES along with the resulting effects on the criterion variable, G_c, is an example of cooperative suppression. Cohen and Cohen describe cooperative suppression as the case in which the intercorrelation of two independent variables involves a portion of their variance which is irrelevant to the criterion variable. The partialling of these predictor variables from the others enhances all indices of relationship with the criterion variable. It is a completely symmetrical phenonemon; whenever it is determined that $\underline{X}_2$ suppresses $\underline{X}_1$, it is also evident that $\underline{X}_1$ suppresses $\underline{X}_2$. One indication of cooperative suppression is a situation in which a beta coefficient exceeds its simple $\underline{r}$ with the dependent variable and is of the same sign. With reference to Table 3, it can be seen that beta coefficients for both SES and family size in the economic model meet this criterion.

An analysis of suppression effects was performed to ascertain what, if any, relationships might exist in the present sample which could have resulted in the suppression of predicted family configuration effects on G_c. In order to identify the nature of the specific suppressor relationships between the predictor and criterion variables, the partial correlation coefficients were calculated for several predictor variables and G_c, with the potential suppressor effects of the predictor variables statistically controlled. The obtained multiple regression and partial correlation coefficients are found in Figure 2. Results for the partial correlation procedure will be discussed separately for each individual model.

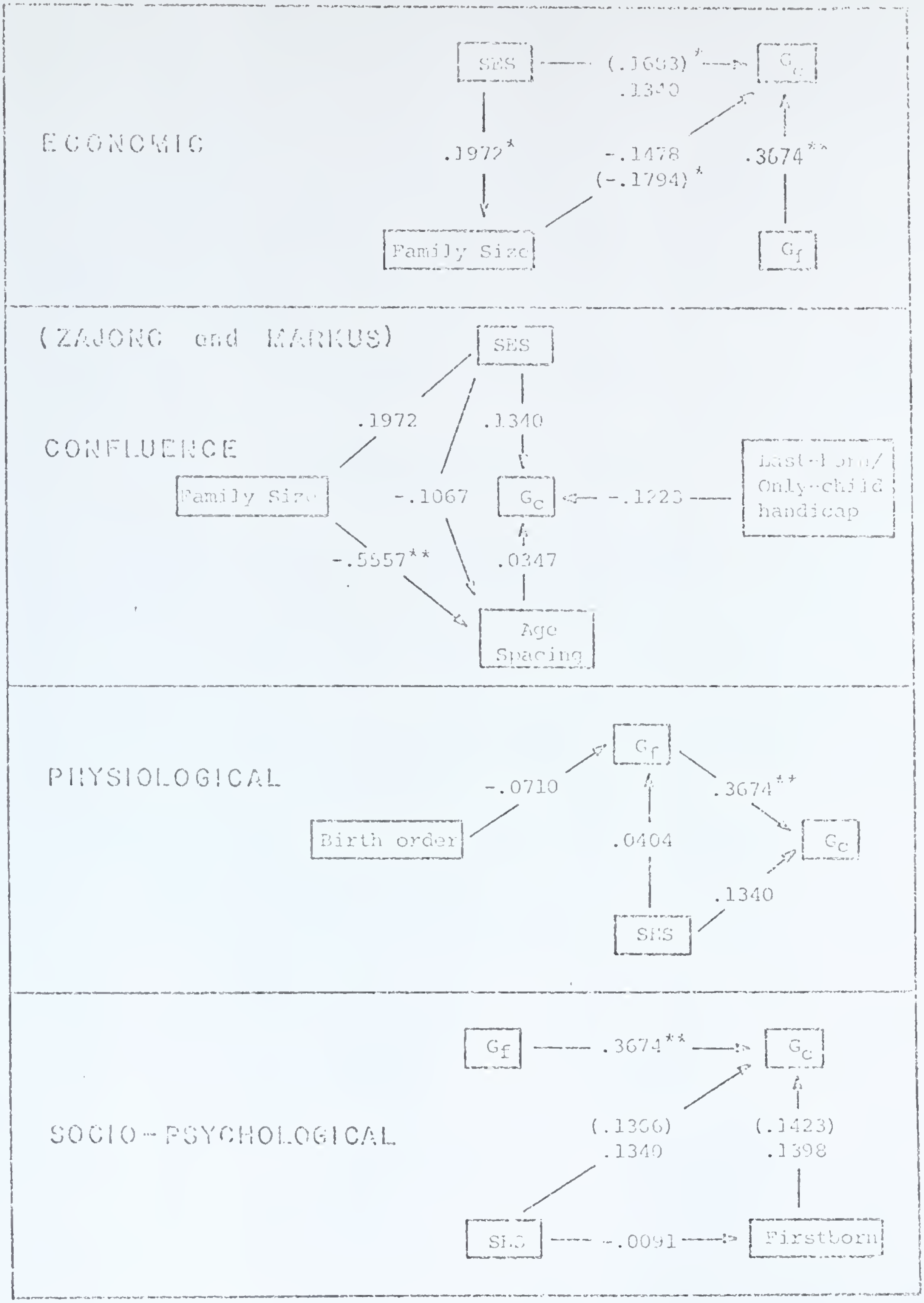
Economic model. With reference to the economic model, it was evident that the unexpected positive correlation between family size and SES suppressed the predicted significant correlations of both family size and SES with the G_c construct. When the effect of family size was partialled from the SES-G_c relationship, the correlation between these two variables was significant (+.1683, $\underline{p} < .05$). Similarly, when the

Figure 2

Intercorrelations among Variables in each Model
for the College Student Sample.

Numbers in parentheses indicate partial correlations between
the independent and criterion variables.

Significance levels: $*p < .05$, $**p < .01$.


ECONOMIC
SES
(.1683)*
.1340
G_c
.1972*
-.1478
(-.1794)*
.3674**
Family Size
G_f
(ZAJONC and MARKUS)
CONFLUENCE
SES
.1972
.1340
Family Size
-.1067
G_c
-.1223
Last-born/
Only-child
handicap
-.5557**
.0347
Age
Spacing
PHYSIOLOGICAL
G_f
-.0710
.3674**
Birth order
.0404
G_c
.1340
SES
SOCIO-PSYCHOLOGICAL
G_f
.3674**
G_c
(.1366)
.1340
(.1423)
.1398
SES
-.0091
Firstborn

suppressor effects of the significant positive correlation between family size and SES were controlled, a modified version of the economic model was supported by the present results. The hypothesized relationships between the predictor variables and the criterion variable were significant when the suppressor effects were controlled. This model was termed "modified" because of the significant positive, not negative, correlation between family size and SES. In a more heterogeneous sample, it would appear likely that the unmodified version of the economic model would be supported due to the generally reported negative correlation between family size and SES (Belmont & Marolla, 1973; Eysenck & Cookson, 1970; Murray, 1971; Nisbet & Entwistle, 1967; Record et al., 1969).

Zajonc-Markus confluence model. Since the overall $\underline{F}$ ratio was non-significant, it was considered inappropriate to further analyze specific predicted relationships of this model. It is quite possible that the unimpressive predictive power of this model may have been attributable to the restricted range of the present sample and/or the unexpected relationships which may be specific to a college student population. Such unexpected trends might suppress the relationships between SES and age spacing between siblings and, in turn, between age spacing and G_c. Similarly, in a study of ability of 291 community college students, as measured by Factor B of the 16 PF, McCutcheon (1977) found little support for the confluence model. She concluded that this model may have limited application. The overall validity of this model might be expected to be substantially higher in a more heterogeneous sample.

Physiological model. The generally observed negative correlation between birth order and SES, an important component of this model, was not obtained in the college student sample. However, due to this model's predictions that birth order and SES influences would be mediated through G_f, which reflects neurophysiological functioning, further analyses for suppressor relationships were precluded. Since G_f ability was for all practical purposes unrelated to both birth order (r = .0710) and SES (r = .0404), any potential suppression effects among these variables would have been statistically trivial in this particular case.

Socio-psychological model. The possibility of cooperative suppression between the firstborn construct and SES was considered. However, when the relationship between the firstborn predictor variable and G_c was partialled for SES effects, the resulting firstborn-G_c intercorrelation (r = +.1423, p > .05) failed to reach significance. Similarly, although the partialling of the firstborn construct from the SES-G_c correlation slightly improved the predictability of G_c from SES, the correlation (r = +.1366, p > .05) was still nonsignificant.

Although the overall F ratios for three of the four models were significant, when the individual models were analyzed in terms of their separate paths, they were not supported. However, when the existence of certain statistical suppressor effects was recognized and these effects were controlled by partial correlational techniques, a modified version of the economic model was supported.

Study 3

Subjects. Due to certain relationships found in the previous analyses which appeared to be specific to a university student population, a more heterogeneous sample was utilized in the attempt to evaluate family configurational and SES correlates of the G_c construct. This sample consisted of 65 twelfth grade students from the P. K. Yonge Laboratory School of the University of Florida. The student population of this school is stratified so as to be demographically representative of the general population of the state of Florida in terms of economic level and race. This tested sample consisted of 55 white and 10 black students, whose age ranged from 17 to 18 years (mean age = 17.37 years). There were 35 females, 30 males, including 14 firstborns, 2 only children, and 25 last-born children.

Instruments. Six tests were administered to these subjects. The group administration was approximately one hour in length. The tests included three markers of G_f (PMA Spatial Relations, PMA Letter Series, and the Army Alpha Number Series subtests) and three markers of G_c (Horn's Vocabulary subtest, Horn's High-Level Vocabulary Analogies subtest, and the ETS Wide-Range Vocabulary Test). Although a somewhat abbreviated battery was utilized in the third study, the tests were optimal markers of G_f and G_c ability in the initial factor analysis. They were thus considered equivalent theoretically and practically to the longer battery administered to the college student sample. The ETS Wide-Range Vocabulary Test was included because of its stabilized reliability and its particular appropriateness for a high school level sample.

Variables. As in Procedure 2, the variables analyzed were determined a priori by the assumptions of the individual models found in Figure 1 and described in Chapter 1. The variables were fairly normally distributed, with the exception of father's educational level (fathers of 25 subjects had obtained doctorates) and the occupational prestige index (Treiman, 1977). Both variables were somewhat skewed, with relatively more subjects at the higher levels. These two variables, along with mother's educational level, were standardized before they added together for the SES index. Similarly, the individual tests were standardized before they were summed for the G_f and G_c composites.

Family size in this sample ranged from 1 to 10, with a mean family size of 3.6 children. Birth order also ranged from 1 to 10 (mean = 2.4963). The age spacing index for the confluence model was calculated in the same manner as in Study 2, that is, the sum of the number of years to the next oldest sibling and the number of years to the next youngest sibling. Also, the two birth order dichotomizations, firstborn (versus later-born) and the "last-born/only child handicap," were included as predictor variables exactly as they were for the college student sample.

The means and standard deviations of the variables studied in the high school sample are listed in Table 4. The intercorrelations between the variables for the individual models are found in Figure 3.

Method. As in Procedure 2, multiple regression procedures were used to examine the amount of variance accounted for in terms of the observed data and the direct and indirect influences of the hypothesized paths in terms of G_c with regard to the economic, physiological, Zajonc and Markus confluence, and socio-psychological models. Since the

Table 4

Means and Standard Deviations for High School Sample

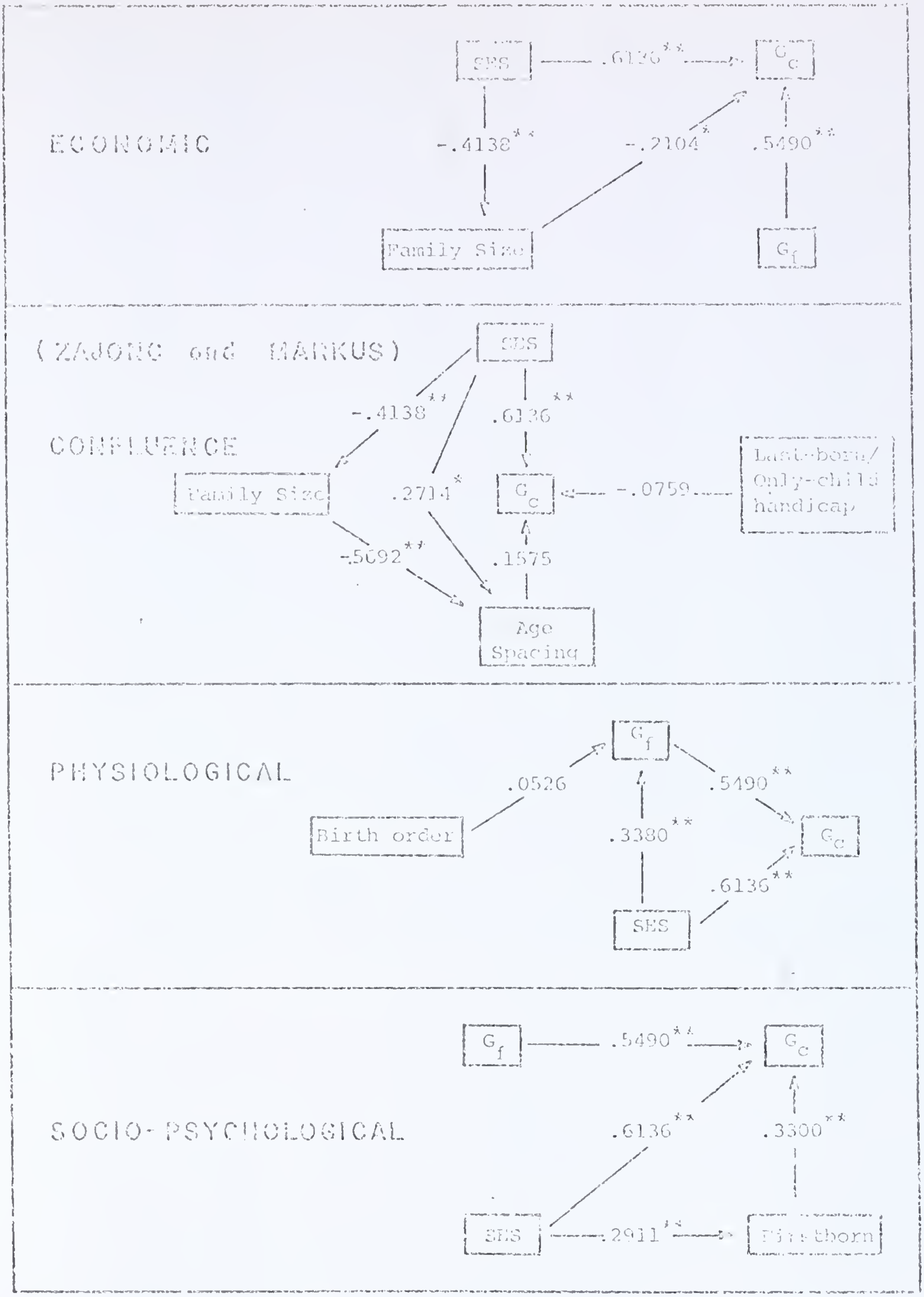
	Mean	Standard Deviation
Age	17.3692	0.4862
Family Size	3.6000	1.6845
Birth Order	2.4963	1.5220
Mother's Education	3.6615	1.3610
Father's Education	4.2308	1.7657
Occupational Prestige	58.0000	17.5944
Age-Spacing Index	15.9219	8.5027
Vocabulary[a]	10.3077	2.1645
Vocabulary Analogies[a]	10.3231	2.3326
Wide-Range Vocabulary[b]	14.1231	3.3237
Letter Series[c]	13.6462	3.4705
Spatial Relations[c]	121.0615	13.6516
Number Series[d]	12.3538	2.9709

[a] Horn "Sampler"
[b] Educational Testing Services
[c] Primary Mental Abilities Test
[d] Army Alpha Examination

Figure 3

Intercorrelations among Variables in each Model
for the High School Student Sample.

Significance levels: $^*\underline{p} < .05$, $^{**}\underline{p} < .01$.


ECONOMIC
SES
.6136**
Gc
-.4138**
-.2104*
.5490**
Family Size
Gf
(ZAJONC and MARKUS)
CONFLUENCE
SES
-.4138**
.6136**
Family Size
.2714*
Gc
-.0759
Last-born/
Only-child
handicap
-.5692**
.1575
Age
Spacing
PHYSIOLOGICAL
Gf
.0526
.5490**
Birth order
.3380**
Gc
.6136**
SES
SOCIO-PSYCHOLOGICAL
Gf
.5490**
Gc
.6136**
.3300**
SES
.2911**
Firstborn

assumptions of the individual models remained the same, the hierarchical specified inclusion method with G_c as the criterion variable which was described in Study 2 was used. _F_ ratios were calculated for each model and for the successive inclusion of each predictor variable within each model. The individual models were also compared to each other for the overall variance accounted for in terms of the obtained data.

Results. The results of the multiple regression analyses are listed in Table 5. It is apparent that all of these models yielded better predictions of G_c performance in the more heterogeneous high school sample examined in this procedure. Not only were the overall _F_ ratios for all of the models significant ($p < .01$), but the overall variance explained by the economic, physiological, Zajonc-Markus, and socio-psychological models was approximately 51%, 52%, 40%, and 54%, respectively. However, while the variance accounted for by each model was substantial, the regressions of all of the individual predictor variables on G_c were significant only for the economic and socio-psychological models. Results for the multiple regression analyses will be discussed separately for each individual model.

Economic model. In contrast to the unexpected positive correlation between family size and SES ($r = +.1972$, $p < .02$) found in the more homogeneous college sample, the predicted negative correlation between these two variables was found for the high school population ($r = -.2104$, $p < .05$). This negative correlation has been widely reported in other studies (Belmont & Marolla, 1973; Eysenck & Cookson, 1970; Murray, 1971; Nisbet & Entwistle, 1967; Record et al., 1969) and is an essential component of the economic model, in which it is proposed that birth order and family size influences are largely reducible to SES and the economic factors

Table 5

Multiple Regression of Predictor Variables for High School Sample

Model Predictor[a]	df	R^2	R^2 Change	Simple r	beta	F
Economic	3/61					21.0675**
1. G_f	1/61	.30142	.30142	.54902	.39115	37.4435**
2. Family Size	1/61	.35320	.05179	-.21045	-.02823	6.4335*
3. SES	1/61	.50887	.15516	.61356	.46968	19.3366**
Confluence	4/60					9.6343*
1. Handicap	1/60	.00576	.00576	-.07591	-.15057	0.5592
2. Age Gaps	1/60	.05981	.05404	.15745	.11250	5.2466*
3. Family Size	1/60	.07563	.01582	-.21045	.07872	7.3427*
4. SES	1/60	.39510	.31947	.61356	.62345	31.0165**

Table 5 - continued

Model Predictor[a]	*df*	R^2	R^2 Change	Simple *r*	beta	*F*
Physiological	3/61					21.4953**
1. G_f	1/61	.30142	.30142	.54902	.39779	37.7719**
2. SES	1/61	.50823	.20681	.54902	.45924	25.9160**
3. Birth Order	1/61	.51347	.00524	-.17525	-.07592	0.6566
Socio-Psychological	3/61					23.8764**
1. G_f	1/61	.30142	.30142	.54902	.39611	40.1893**
2. Firstborn	1/61	.39351	.09209	.33000	.18679	12.2787**
3. SES	1/61	.54007	.14646	.61356	.42531	19.5413**

Note. The *F* value on the same line as each specific model name indicates the overall *F* of the model.

[a]Numbers preceding predictor variables indicate their order of inclusion into the hierarchical regression analysis.

*$p < .05$.

**$p < .01$.

involved (Anastasi, 1956; Kennett, 1973; Schooler, 1972, 1973). Moreover, the predicted significant increments to the explained sum squares attributed to each successive predictor variable (G_f, family size, and SES) in the hierarchical decomposition procedure were statistically supported. It was concluded that, in addition to the ability to account for a very substantial amount of variance in the obtained data, an unmodified version of the economic model was fully supported in the more heterogeneous high school sample.

Zajonc-Markus confluence model. In contrast to the findings with regard to this model (Zajonc, 1976; Zajonc & Markus, 1975) in the college student sample, the overall significant *F* ratio for the high school sample permitted the further analysis of the individual predicted relationships of the confluence model. After examining these results, however, it became evident that, while the age-spacing index, family size, and SES were adequate predictors of the criterion variable, the "handicap" of lastborn and only children (ostensibly due to their lack of opportunity to serve as teachers to younger siblings) was not an adequate predictor of G_c performance. Therefore, the confluence model was not fully supported by the obtained data.

Physiological model. In the physiological model (Warren, 1966; Weller, 1965), emphasis is placed on physiological mediators of birth order differences in cognitive ability, such as mother's age, length of labor, and perinatal complications. Again, an overall *F* ratio and a substantial amount of the variance in G_c performance accounted for permitted further analysis of the individual components of this model. The first two predictor variables in the multiple regression equation, G_f and SES, were significantly predictive of G_c scores. However, birth order, whose correlation of -.1752 ($\underline{p} > .05$) with G_c failed to attain significance in this sample, also failed to add significantly to the explained sum of squares for the physiological model. Thus, it was concluded that this model was not supported by the data.

Socio-psychological model. Proponents of this model (Bradley, 1968; Burton, 1968; Glass et al., 1974; Murray, 1971; Nuttall et al., 1976; Start & Start, 1974) discuss family configuration influences in terms of significant social and psychological factors. The variance accounted for in terms of the data from the high school sample was 54% for this model, the most substantial of all the models. Also, after analyzing the individual paths, it was evident that the predictor variables, G_f, firstborn (versus later-born), and SES, were each significant predictors of the criterion variable, in terms of both simple correlations and individual paths.

Summary. After analyzing the economic, confluence, physiological, and socio-psychological models in terms of both total variance accounted for and in terms of the individual paths, the models which were fully supported were the economic and socio-psychological models, which explained 51% and 54% of the variance, respectively. Although both models were supported, the question as to which model was the optimal predictor of G_c performance in the heterogeneous high school sample had to be considered. The overall $\underline{F}$ ratios for both models were highly significant ($\underline{p} < .01$). Also, highly significant $\underline{F}$ ratios ($\underline{p} < .01$) were obtained for both G_f and SES, predictor variables in both models. However, when family size (the second variable to enter the regression equation of the economic model) was compared to firstborn (the second variable of the socio-psychological model), it was found that the $\underline{F}$ ratio for the firstborn variable was 12.2787 ($\underline{df} = 1/62$, $\underline{p} < .01$), more significant than the $\underline{F}$ ratio for family size ($\underline{F} = 6.4335$, $\underline{df} = 1/62$, $\underline{p} < .05$). Thus, when the $\underline{F}$ ratios for the individual hypothesized paths were evaluated, it was evident that the predictor variables of the socio-psychological model were more strongly related to G_c than were the individual components of the economic model. It was concluded that--although both the economic and socio-psychological models were fully supported by the data--the socio-psychological model was the optimal predictor of achievement-related performance in this sample, in terms of both overall variance accounted for and with regard to the significance levels of the individual hypothesized paths.

CHAPTER III

DISCUSSION

Although sibling constellation correlates of intellectual abilities have been studied extensively, the results have often been difficult to interpret. The contradictory findings and tentative conclusions are partially attributable to the highly confounded nature of birth order and family size variables. Interpretations are further complicated by the relationships between ability, achievement, and personality and the intercorrelations of SES with both family size and the personality-ability-achievement complex (Eysenck & Cookson, 1970).

In the present study, an attempt was made to separate out some of the confounded relationships between family configuration, SES, and the performance on ability and achievement measures. In the initial procedure, a battery of 21 tests was administered to 111 university students. After factor analyzing the resulting correlation matrix for optimal marker variables of the fluid intelligence (G_f or active problem-solving ability) and crystallized intelligence (G_c or achievement-related performance) constructs of Cattell and Horn (Cattell, 1941, 1963, 1967; Horn, 1966, 1968, 1970, 1975; Horn & Cattell, 1966, 1967), four linear structural equation models relating G_c to various hypothesized predictor variables were evaluated for two separate samples, the original university student sample and a more heterogeneous sample of high school students.

The four models emphasized the importance of either economic, "intellectual environment" (confluence), physiological, or socio-psychological influences in the mediation of birth order and/or family size effects on intellectual ability. Proponents of the economic model (Anastasi, 1956; Kennett, 1973; Nisbet & Entwistle, 1967; Schooler, 1972, 1973) contend that family size effects are largely reducible to SES and related economic advantages and restrictions. The confluence model (Zajonc, 1976; Zajonc & Markus, 1975) considers ordinal differences in intelligence in terms of family size and age spacing between siblings and the resultant influences of the family's immediate "intellectual environment" on intellectual development. In the physiological model (Warren, 1966; Weller, 1965), it is suggested that physiological factors are important mediators of birth order differences in cognitive ability. Advocates of the socio-psychological model (Bradley, 1968; Burton, 1968; Glass et al., 1974; Nuttall et al., 1976; Start & Start, 1974) contend that birth order, particularly firstborn academic superiority, appears to be importantly related to significant social and psychological factors. Such influences are often discussed in terms of personality and motivational differences which may be manifested in individuals of differing family sizes and ordinal positions. Issues and assumptions relevant to these models were discussed in the first chapter. It was emphasized that these theories are not mutually exclusive. It was suggested that, as SES level increases, physiological, "intellectual environment," and economic variables might conceivably exert less influence, and that socio-psychological variables might exert relatively more influence on family configurational effects.

University Student Sample

It was predicted that the socio-psychological model would be the best predictor of achievement-related performance, or G_c, in this sample. In the second procedure, multiple regression linear structural equation techniques were utilized to evaluate the amount of variance accounted for in terms of the observed data and for the individual hypothesized paths for each of the models in a college student sample. The overall significant F ratios for the economic, physiological, and socio-psychological models were found to be attributable to the significant positive regression of G_f on G_c (r = +.3674, $p < .01$), the variable entered at the first step in each of these models. The overall F ratio of 2.2989 for the confluence model was not significant. The results of this multiple regression analysis are listed in Table 3. Therefore, while the prediction that ordinal position would significantly influence G_c performance (r = .1633, $p < .05$) but not G_f performance (r = .0710) was supported, none of the models appeared to be adequate predictors of the G_c construct in this sample. However, upon closer examination of the results, certain unexpected relationships among the predictor variables were observed. It seemed reasonable that such relationships might be specific to a college sample, as they have not been generally reported in studies of more heterogeneous samples. These relationships acted to statistically suppress the validity of several of the predictor variables to explain performance on the G_c composite.

It was concluded that the contention that ordinal position effects might not persist into adulthood (Schooler, 1972, 1973) may be particularly evident in a university student sample. While the attenuation of birth order and family size effects in higher SES samples has been widely reported, the results of the present procedure suggested that such effects might not only be attenuated, but might be reversed, in a college population. These reversals appear to be largely attributable to certain relationships which may be specific to such a sample. Specifically, the unexpected significant positive correlation between family size and SES ($r = +.1972$, $p < .02$) was in marked contrast to the often reported negative intercorrelation of these two variables in more heterogeneous samples (Belmont & Marolla, 1973; Eysenck & Cookson, 1970; Murray, 1971; Nisbet & Entwistle, 1967; Record et al., 1969). This unexpected finding was interpreted in terms of financial resources and limitations, which play an important and perhaps decisive role in college attendance. Given this positive relationship between family size and SES in addition to the highly confounded nature of the relationship between family size and birth order, it was not surprising to find a positive, although nonsignificant, correlation between birth order and SES ($r = +.1200$, $p < .10$). The effect of these relationships was to alter the hypothesized interrelationships among certain predictor variables, which in turn rendered straightforward interpretation of the individual models difficult.

After further analysis of the data, it was determined that cooperative suppression, as described by Cohen and Cohen (1975), existed among several of the predictor variables. When partial correlation procedures were utilized to statistically control for these suppressor effects, a modified version of the economic model was supported, in terms of both overall predictive significance and with regard to the hypothesized relationships of the individual paths and the achievement-related construct. The economic model was termed "modified" due to the significant positive, not the predicted negative, correlation between family size and SES.

Even with suppressor effects controlled, the prediction that the socio-psychological model would be the optimal predictor of G_c performance in this sample was not supported. Reasons for this result were not obvious, although the unexpected positive relationships between SES level and the family size/birth order variables appear to have been an important contributing factor to these negative results. Economic restrictions and other issues related to SES might conceivably exert less influence on the opportunity of firstborn--as opposed to later-born--siblings to receive a higher education. The widely reported finding of firstborn overrepresentation at the college level (Altus, 1966; Capra & Dittes, 1962; Schachter, 1963) has led some investigators to contend that firstborns may be more able (Nichols, 1964; Terman, 1925) or more achievement-oriented (Breland, 1974; Burton, 1968; Forer, 1976; Glass et al., 1974; Nuttall et al., 1976). However, in light of the present findings, the possibility that economic factors importantly mediate firstborn college attendance should also be considered.

High School Sample

Due to certain unexpected relationships in the previous procedure which might conceivably be specific to a college student sample, it was decided to evaluate the ability of the four models to predict G_c performance in a more heterogeneous sample. Six tests which were assumed to represent G_f or G_c ability were administered to 65 high school seniors. The results for the hierarchical specified inclusion methods for this sample are listed in Table 5. It was found that all of the models were better predictors of G_c performance in terms of overall variance and with regard to the individual paths. In contrast to the college student sample results, the predicted negative correlation between family size and SES ($r = -.2104$, $p < .05$) was obtained for this more heterogeneous sample. However, while the overall F ratios for all of the models were significant, the regressions of the individual predictor variables on G_c were significant only for the economic and socio-psychological models, which explained approximately 51% and 54% of the variance, respectively. It was concluded that, not only were the economic and socio-psychological models fully supported in this sample, but that they were both able to account for very substantial amounts of the variance in the prediction of G_c performance. In an effort to determine which of these two models was the most predictive of G_c, the individual paths postulated by these models were examined. Due to the observation that the firstborn variable of the socio-psychological model was a more highly significant predictor of G_c performance than was the family size variable of the economic model, it was concluded that the hypothesis that the socio-psychological model would most adequately explain achievement-related performance was supported.

It was evident that the current versions of the physiological and Zajonc and Markus confluence models were less adequate predictors of G_c performance, particularly for the more heterogeneous high school sample. This observation might have important implications with regard to future consideration of these models. It is conceivable that modified versions may have to be considered. For example, the present results indicate that the Zajonc and Markus "last born/only child handicap" variable may have to be more carefully formulated. This predictor variable was not significantly related to G_c for either sample. Moreover, contrary to the predictions, there was a trend for only children to perform somewhat better than the other subjects on G_c measures. For the college sample the correlation between only child and G_c was +.1438 ($p < .10$), in contrast to the significant negative correlation between lastborn and G_c ($r = -.1831$, $p < .05$). Similarly, the correlations of G_c with only child and lastborn for the high school sample were +.1299 ($p > .10$) and -.1236 ($p > .10$), respectively. Thus, it is conceivable that only children should not be included in this "handicap" category. However, due to the small number of only children in this investigation and the very different relative representations in both samples (4 only children as opposed to 35 lastborn children in the college sample; 2 only children as opposed to 25 lastborn children in the high school sample), any statistical comparison with regard to these constructs would have been extremely unstable.

With regard to the physiological model, the contention that birth order correlates of intellectual performance might be largely physiological in origin was seriously challenged by the statistically trivial inter-correlations between birth order and G_f of .0710 for the college sample and .0526 for the high school sample. This very negative result concerning the basic component of this model--the influence of birth order on the physiological mediation of intellectual ability performance--indicates the need for considerable reformulation in terms of the theoretical predictions of the physiological point of view, particularly in terms of birth order effects. A serious shortcoming appears to be the contradictory predictions associated with ordinal position. More specifically, whereas the discussion of mother's age, increased chance of genetic error, and "uterine fatigue" (Warren, 1966) indicates deleterious birth order influences for later-born children, the problems often associated with the pregnancy and birth of the firstborn child, including a smaller placenta, longer labor, and increased perinatal complications (Weller, 1965) suggest relative physiological advantages for later-born children. Before further consideration of even a modified version of this model is indicated, it is apparent that such complex predictions concerning the physiological influences of birth order will have to be more carefully isolated.

It is apparent from the present results that certain social and psychological factors may be significant mediators of family configuration influences--particularly firstborn superiority--on intellectual achievement. Moreover, economic influences seem to exert powerful effects, both directly and indirectly, on intellectual ability performance.

Implications

With regard to the very different results obtained for the college student and high school student samples, it is apparent that one must specify the kind of sample involved when addressing issues related to family configuration and SES correlates of intellectual ability. Kennett's (1973) discussion of the importance of SES influences on the relationships between family size and intelligence seems particularly appropriate to the results of the present investigation. The failure of many studies to separate out the confounded relationships between family configuration, SES, and other related variables, which may differ widely depending on sampling techniques, may be a major contributor to the contradictory findings and tentative conclusions so prevalent in this literature.

An issue which should be considered in the study of relatively homogeneous samples, such as the university students in the present investigation, is the possible restriction in range in terms of certain family configuration variables, SES, and ability. Differences in restriction in range across samples may result in difficulties in comparison and interpretation. Moreover, such restrictions may be differentially manifested for different variables. For example, in the college sample, SES appeared to be the predictor variable which manifested the least restriction in range. In contrast, while the SES construct had relatively more variance in the heterogeneous high school sample, the age range of from 17 to 18 years was extremely narrow. This age constant aspect of the high school sample may have been an important contributing factor to the increased correlations obtained among the predictor variables and G_c.

Thus, while age was not included as a predictor variable in any of the four models evaluated in this study, it is conceivable that a potentially important predictor of G_c performance of the university students in this study was the age of the subjects. While it might generally be assumed that a college student population is homogeneous in many ways, this assumption may be decreasingly valid with respect to age. The age range of 17 to 30 years in this sample reflects the increasing tendency for older students to attend universities, at both undergraduate and graduate levels. Future studies of family configuration correlates of intelligence and achievement among college students may have to take this trend into account. Considerable differences in age may present problems in interpretation in such studies. For example, there existed in the present college sample a highly significant positive correlation between age and G_c performance ($\underline{r}$ = +.2753, $\underline{p} < .01$) but a nonsignificant negative relationship between age and G_f ability ($\underline{r}$ = -.0999). It is interesting to note that this age trend for these constructs is in agreement with Horn's (1970, 1975) postulated age-range functions of G_f and G_c abilities. As described by Cunningham, Clayton, and Overton (1975), this theory predicts that:

> Fluid intelligence, which is purported to reflect the functioning of neurological structures, increases until the cessation of neural maturation, generally during adolescence, and then declines thereafter. In contrast, crystallized intelligence is believed to reflect cultural assimilation. In particular, it seems to be highly influenced by formal and informal educational factors throughout the life span. Assuming adequate health, crystallized intelligence is presumed to increase steadily across the adult age span. (p. 53)

However, although of theoretical interest, this cross-sectional age-related increase on G_c or achievement-related measures may be attributable to factors unrelated to Horn's contentions. For example, age and college level (freshman, junior, graduate student, etc.) are highly confounded. It is very difficult to separate the effects of age and ability in a cross-sectional design such as that employed in the present study. However, the influence of age in such samples may be an important factor which should be taken into consideration in future studies.

Another potentially important issue is the possible existence of different family configuration mediators of intellectual ability performance with regard to racial background. Such race-related differences might be expected to be particularly evident in terms of SES and family size influences on intellectual ability measures. Zajonc and Markus (1975) discuss the possible relationships between family configuration variations among different national, regional, ethnic, and racial groups and differences in intellectual test performance. They suggest that differences in family configuration patterns, including larger families and closer age spacing between siblings, in the black population may be a contributing factor to racial differences in intellectual performance scores. The high school sample in the present investigation included ten black subjects. The student body of this particular school is stratified so as to be demographically representative of the state of Florida in terms of economic level and race. Therefore, this sample was considered to be a representative one, in contrast to the relatively homogeneous and somewhat artificial university student sample. Although it would have been interesting to examine specific patterns among the predictor variables and G_c, in addition to the predictive ability of the individual models, across the two racial groups of the high school sample, the small absolute number of black students and the very different relative sample sizes (10 black students and 55 white students) precluded further statistical analysis.

The present investigation introduced several new approaches to the study of family configuration and intellectual achievement which may possibly have important application for this research area. Specifically, the use of the G_f and G_c constructs of Cattell and Horn (Cattell, 1941, 1963, 1967; Horn, 1966, 1968, 1970, 1975; Horn & Cattell, 1966, 1967) as measures of aptitude- as opposed to achievement-related ability, the use of multiple regression techniques to evaluate the predictive ability of the different path models, and the analysis of suppressor effects may be potentially effective tools for future studies of birth order and family size relationships to intelligence.

Fluid and Crystallized Intelligence

Significant ordinal position influences on achievement-related variables but not on certain aptitude or ability measures have been reported (Burton, 1968; Forer, 1976; Glass et al., 1974; Nuttall et al., 1976). These findings suggested to the author the possible application of the G_f and G_c constructs of Cattell and Horn as measures of aptitude and achievement-related performance. Horn (1966, 1968, 1970, 1975) hypothesizes that G_f reflects neurophysiological functioning and active problem-solving ability. G_c is defined by abilities appropriated through education and acculturation. Thus, it was decided to utilize G_f measures to represent active problem-solving ability or aptitude and G_c measures to represent achievement-related performance.

Multiple Regression

Marjoribanks (1976a, 1976b) contends that the equivocal results reported in the birth order literature are partially due to the use of restricted statistical techniques which have precluded examination of the full character of the sibling constellation correlates of intellectual abilities. The majority of studies have used product-moment correlations, which reveal only bivariate relationships, and analysis of variance, which requires the grouping of variables into levels. Marjoribanks et al. (1975) suggest that the use of multiple regression techniques--which provide a goodness-of-fit for any functional form of the variables and do not require grouping--should overcome some of the statistical shortcomings of many previous investigations. In the present study, hierarchical specified inclusion techniques were used to test the assumptions of four individual models.

This statistical technique was chosen because it permits the analysis of the relationship between a criterion variable and a set of predictor variables without the artificial grouping of variables into levels. Moreover, the estimation of the relative strengths of the individual paths in the models indicates the magnitude of both direct and indirect influences in terms of the hypothesized causal ordering for each model. In the hierarchical inclusion procedure, each predictor variable is added in a single step, and the increment in $\underline{R}^2$ at each successive step is considered to be the component of variation attributable to that particular variable.

Statistical Suppression

Although statistical suppressor effects are rather uncommon in behavioral sciences research, their existence can be devastating to data interpretation. It was determined that certain unexpected relationships which were observed in the college sample, particularly the significant positive correlation between family size and SES, were acting as cooperative suppressors (Cohen & Cohen, 1975) in at least two of the proposed models. These suppressor effects resulted in a decreased relationship between the family configuration and SES variables and the achievement-related criterion variable. When partial correlation techniques were utilized to control for these statistical suppressor effects, a modified version of the economic model was supported in terms of both overall variance accounted for and the predictive ability of the individual paths.

The discovery of the existence of suppressor effects in the college student sample may have potentially important implications for the application of multiple regression techniques in general, and for the use of these procedures in family configuration research in particular. It is evident that birth order and family size variables may exert very different effects on intellectual ability and achievement, depending on different sampling procedures and the specific sample investigated. The use of partial correlation techniques to control for statistical suppression may be an important tool in the isolation of the many complex relationships and issues in this literature.

Directions for Future Research

In the present study, an attempt was made to separate out some of the confounded relationships of certain family configuration and SES level correlates of intellectual ability and achievement. The present results--along with the contradictory and tentative conclusions prevalent in this research area--indicate the need for the generation of new theories and hypotheses, which may be specific to particular samples. The four models evaluated in this investigation should not be considered to be mutually exclusive. Moreover, it is conceivable that alternative models may be equally or even more predictive of certain family configuration influences. For example, in a sample consisting of 185 11-year-old boys, Marjoribanks et al. (1975) found that a multiple regression equation containing father's occupational status, inverse of the number of children in the family, and the product of the two variables accounted for as much significant variance as complex equations with many terms.

With regard to the present results, it is evident that, besides the variables examined in this investigation, certain additional variables should possibly be considered in future family configuration studies. Such general influences include subject sex differences, sex of siblings, age range of subjects, and the possible mediation of racial and ethnic influences on intellectual ability performance.

Moreover, the supported predictions concerning firstborn superiority on achievement-related variables might be more analytically evaluated in a variety of ways. Such analytical paths might include separate analyses for specific mechanisms related to the performance of firstborn children on achievement-related measures. For example, SES mediators of such firstborn superiority might include parental attitudes toward achievement and educational aspirations which may differ across SES levels, especially regarding earlier-born children (Glass et al., 1974), certain concrete measures such as the number of books, periodicals, and other literature in the home, and parental role models--which might be particularly interesting for the daughters of achieving women. Another area of investigation might involve certain personality attributes which might be related to firstborn performance on achievement-related variables. Such attributes might involve increased susceptibility to social pressure and sensitivity to tension-producing situations (Bradley, 1968), conscientiousness and effort (Start & Start, 1974), social conformity and achievement motivation (Forer, 1976). The examination of these hypothesized contributors to firstborn superiority on achievement-related performance might further clarify certain family configuration correlates of intellectual ability performance. Of particular relevance to these considerations is the importance of differential learning environments created by families for their children (Marjoribanks, 1976a). These learning environments were described in terms of five process variables: (a) press for achievement; (b) press for activeness; (c) press for intellectuality; (d) press for independence; and (e) press for English (related to the reinforcement of the correct use of English). Marjoribanks indicates that the relationships between birth order and cognitive performance are complex:

> The findings support the proposition that, if parents provide different environmental experiences for their children, then the environmental differences will be related to birth-order variation in the cognitive performance of children. (p. 764)

It is thus apparent that the often contradictory findings and tentative conclusions in the birth order and family size literature may be largely attributable to the failure to adequately control for the many confounded variables and possible artifactual relationships which may exist in certain samples. The results of the present investigation indicate the need for the generation of new, more analytical hypotheses with regard to family constellation influences on aptitude and achievement. Moreover, the utilization of innovative statistical techniques and conceptual approaches may serve to effectively isolate the extremely complex family configuration correlates of intellectual ability performance.

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BIOGRAPHICAL SKETCH

Sandra Johnson Witt was born in Sanford, Florida, on July 17, 1946, the daughter of Betty Beeler Johnson and Elmer Hunter Johnson. She graduated from Hialeah Senior High School in Hialeah, Florida. A German major at the University of Florida, she graduated in 1968 with high honors and was elected to Phi Beta Kappa. She received her master's degree in German and French from the University of Florida in 1969. She worked for Trans World Airlines in New York until 1971 as an international airline hostess and in-flight instructor. She married William Morris Witt in 1971. In 1973 she received a master's degree in psychology from Emory University under the direction of Dr. Philip Dreyer and Dr. Boyd McCandless. She worked as staff psychologist and director of adult remedial education at the Key Training Center for Mentally Retarded and Physically Handicapped Adults in Lecanto, Florida, from 1973 until 1974. In 1975 she entered the Ph.D. program in developmental psychology at the University of Florida. While in this program, she received a pre-doctoral fellowship from the Center for Gerontological Studies and worked as a research assistant for Dr. Walter R. Cunningham, who is also the chairman of her doctoral committee. She has two daughters, Amanda and Katherine.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Walter R. Cunningham

Walter R. Cunningham, Chairman
Assistant Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

William Keith Berg

William Keith Berg
Associate Professor of Psychology

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This dissertation was submitted to the Graduate Faculty of the Department of Psychology in the College of Arts and Sciences and the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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